

# PETAWATT

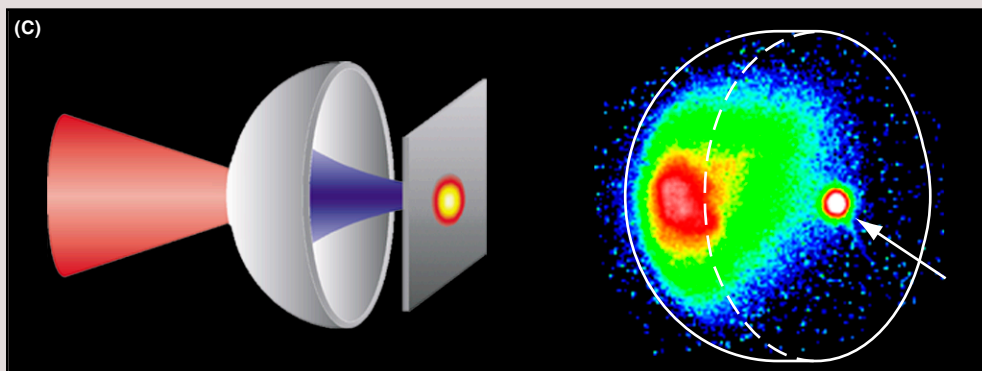
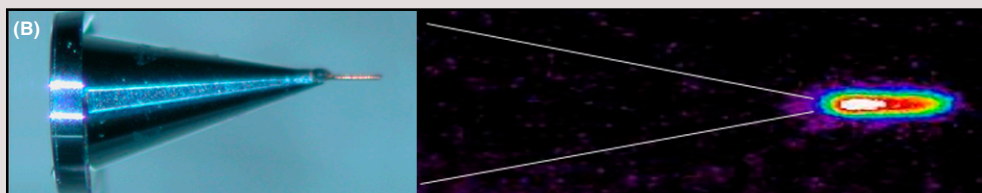
## LASER BASED STUDY OF MATTER AT EXTREMELY HIGH ENERGY DENSITIES

When jokers refer to LLNL as an acronym for “Lasers Lasers Nothing (but) Lasers they wrongly ignore the huge range of science at the laboratory but they rightly identify one of the outstanding features of that science. For three decades LLNL has pioneered the extremes of power and energy that can be generated with lasers. The world’s first petawatt (PW) laser (one thousand trillion watts) was built at LLNL in 1996 and the first megajoule laser (one million joules), the National Ignition Facility, is now nearing completion in a stadium-sized building that is a landmark feature at the laboratory. A major motivation for developing such lasers is that they make it possible to create concentrations of energy in small volumes of matter that vastly exceed what can be accomplished in any other way and mimic conditions in stars

and other astrophysical phenomena. They open the way to precise study of high energy density (HED) matter in the laboratory and present a path to achieve controlled thermonuclear fusion. The Presidents Office of Science and Technology Policy has made HED science a priority topic. The talk will describe some current experiments in this developing field, highlighting international collaborations and the significant role of graduate students and staff from several US Universities. Both the short-term goals for scientific discovery and longer-term possibilities for fusion energy will be outlined. It is fitting to mention also in this centenary year of his achievements, the seminal work of Albert Einstein whose concept of stimulated emission of light provides the basis for all lasers.



(A) LLNL scientist adjusts instruments in the vacuum target chamber of the UK Vulcan PW laser. (B) The Vulcan PW laser is focused into a hollow cone of Al and generates a 100 mega ampere current of megavolt electrons which are guided into a Cu wire 1/10 the thickness of a human hair. The image shows characteristic x-



ray fluorescence from the Cu wire. (C) The Gekko PW laser in Japan irradiates a 400 micron diameter hemispherical shell and generates a focused beam of MeV protons which heat a 100 micron thick Al foil. The image shows an intense spot of thermal x-rays (arrow) from the HED plasma heated by the proton beam.